

Claims:

1. A method of automatically controlling the filling of a plurality of tanks with a liquid from a supply source, the plurality of tanks being equipped with overflow sensing means that detects an overflow condition indicative of the plurality of tanks being filled to capacity, said method comprising the

steps of:

coupling a controllable valve to the supply source wherein the liquid dispensed therefrom must pass through said controllable valve when the plurality of tanks are being filled;

providing an increment that said controllable valve can be opened and closed when liquid is being dispensed therethrough;

opening said controllable valve to an initial position, wherein said initial position defines a flow rate through said controllable valve that falls within a range of acceptable flow rates;

dispensing the liquid from the supply source through said controllable valve in said initial position;

monitoring, for an amount of time, each of (i) a flow rate of the liquid being dispensed, (ii) a level of the liquid in each of the plurality of tanks, and (iii) a state

24 of the overflow sensing means, wherein (i) an average flow  
25 rate, (ii) an average level, and (iii) an average state,  
26 respectively, are defined for said amount of time;

27 moving said controllable valve by said increment when  
28 said average flow rate is outside said range of acceptable  
29 flow rates, wherein said controllable valve is closed by an  
30 amount equal to said increment when said average flow rate is  
31 greater than said range, and wherein said controllable valve  
32 is opened by an amount equal to said increment when said  
33 average flow rate is less than said range;

34 waiting a predetermined wait time following an  
35 occurrence of said step of moving; and

36 initiating a finalize filling process when one of a  
37 number of events occurs, said number of events including (i)  
38 said average level being equal to a predetermined percentage  
39 of the capacity of the plurality of tanks, and (ii) said  
40 average state indicating said overflow condition, said  
41 finalize filling process fully closing said controllable  
42 valve in accordance with a series of discrete movements of  
43 said controllable valve carried out over a specified time  
44 period; and

45 repeating said steps of monitoring, moving and waiting  
46 until one of said number of events occurs.

1        2. A method according to claim 1 wherein said predetermined  
2        wait time used in said step of waiting is equal to the sum of  
3        (i) a first time interval equal to the time needed for said  
4        controllable valve to move said increment, and (ii) a second  
5        time interval selected to allow said flow rate to settle out  
6        after said controllable valve moves said increment.

1        3. A method according to claim 1 wherein  
2                the plurality of tanks are part of a seawater-  
3        compensated system with the plurality of tanks being coupled  
4        together in a series configuration,

5                the supply source is coupled to a first tank in the  
6        series configuration via said controllable valve, and

7                prior to said step of repeating, said method further  
8        comprises the steps of:

9                monitoring, for said amount of time, pressure in one of  
10       the plurality of tanks wherein an average pressure is defined  
11       for said amount of time;

12               closing said controllable valve by an amount equal to  
13       said increment when said average pressure exceeds a pressure  
14       threshold; and

15               waiting said predetermined wait time following an  
16       occurrence of said step of closing.

1        4. A method according to claim 1 wherein

2            the plurality of tanks are part of a seawater-  
3 compensated system with the plurality of tanks being coupled  
4 together in a series configuration,

5            the supply source is coupled to a first tank in the  
6 series configuration via said controllable valve and an  
7 overflow reservoir is coupled to a last tank in the series  
8 configuration with the overflow reservoir having an orifice  
9 through which seawater flows when the liquid is being  
10 dispensed to fill the plurality of tanks, and

11           said step of monitoring said flow rate comprises the  
12 step of monitoring the seawater passing through the orifice  
13 of the overflow reservoir.

1        5. A method according to claim 4 wherein the overflow  
2 sensing means is coupled to the overflow reservoir, wherein  
3 said step of monitoring said state of the overflow sensing  
4 means comprises the step of using the overflow sensing means  
5 to check for presence of the liquid in the overflow reservoir  
6 wherein said presence of the liquid is indicative of said  
7 overflow condition.

1       6. A method according to claim 1 wherein a supply manifold  
2       is coupled between said controllable valve and the plurality  
3       of tanks, wherein said step of monitoring said flow rate is  
4       carried out between said controllable valve and the supply  
5       manifold.

1       7. A method according to claim 6 wherein  
2       an overflow reservoir is coupled to the supply manifold  
3       with the overflow sensing means coupled to the overflow  
4       reservoir, and

5       said step of monitoring said state of the overflow  
6       sensing means comprises the step of using the overflow  
7       sensing means to check for presence of the liquid in the  
8       overflow reservoir wherein said presence of the liquid is  
9       indicative of said overflow condition.

1        8. A method of automatically controlling the filling of a  
2        ship's fuel tanks with fuel from a supply source, the fuel  
3        tanks being equipped with overflow sensing means that detects  
4        an overflow condition indicative of the fuel tanks being  
5        filled to capacity, said method comprising the  
6        steps of:

7                coupling a controllable valve to the supply source  
8        wherein the liquid dispensed therefrom must pass through said  
9        controllable valve when the plurality of tanks are being  
10       filled;

11               providing an increment that said controllable valve can  
12       be opened and closed when liquid is being dispensed  
13       therethrough;

14               opening said controllable valve to an initial position,  
15       wherein said initial position defines a flow rate through  
16       said controllable valve that falls within a range of  
17       acceptable flow rates;

18               dispensing the liquid from the supply source through  
19       said controllable valve in said initial position;

20               monitoring, for an amount of time, each of (i) a flow  
21       rate of the liquid being dispensed, (ii) a level of the  
22       liquid in each of the plurality of tanks, and (iii) a state  
23       of the overflow sensing means, wherein (i) an average flow  
24       rate, (ii) an average level, and (iii) an average state,

25        respectively, are defined for said amount of time;

26            moving said controllable valve by said increment when  
27        said average flow rate is outside said range of acceptable  
28        flow rates, wherein said controllable valve is closed by an  
29        amount equal to said increment when said average flow rate is  
30        greater than said range, and wherein said controllable valve  
31        is opened by an amount equal to said increment when said  
32        average flow rate is less than said range;

33            waiting a predetermined wait time following an  
34        occurrence of said step of moving, said predetermined wait  
35        time being equal to the sum of (i) a first time interval  
36        equal to the time needed for said controllable valve to move  
37        said increment, and (ii) a second time interval based on a  
38        plurality of factors to include the number of fuel tanks and  
39        location of said controllable valve relative to where said  
40        flow rate is being monitored; and

41            initiating a finalize filling process when one of a  
42        number of events occurs, said number of events including (i)  
43        said average level being equal to a predetermined percentage  
44        of the capacity of the fuel tanks, and (ii) said average  
45        state indicating said overflow condition, said finalize  
46        filling process fully closing said controllable valve in  
47        accordance with a series of discrete movements of said  
48        controllable valve carried out over a specified time period;

49           and  
50                 repeating said steps of monitoring, moving and waiting  
51           until one of said number of events occurs.

1           9. A method according to claim 8 wherein  
2                 the fuel tanks are part of a seawater-compensated  
3           system with the fuel tanks being coupled together in a series  
4           configuration,  
5                 the supply source is coupled to a first tank in the  
6           series configuration via said controllable valve, and  
7                 prior to said step of repeating, said method further  
8           comprises the steps of:  
9                 monitoring, for said amount of time, pressure in one of  
10           the fuel tanks wherein an average pressure is defined for  
11           said amount of time;  
12                 closing said controllable valve by an amount equal to  
13           said increment when said average pressure exceeds a pressure  
14           threshold; and  
15                 waiting said predetermined wait time following an  
16           occurrence of said step of closing.



1        10. A method according to claim 8 wherein

2                the fuel tanks are part of a seawater-compensated  
3        system with the fuel tanks being coupled together in a series  
4        configuration,

5                the supply source is coupled to a first tank in the  
6        series configuration via said controllable valve and an  
7        overflow reservoir is coupled to a last tank in the series  
8        configuration with the overflow reservoir having an orifice  
9        through which seawater flows when the liquid is being  
10       dispensed to fill the plurality of tanks, and

11               said step of monitoring said flow rate comprises the  
12       step of monitoring the seawater passing through the orifice  
13       of the overflow reservoir.

1        11. A method according to claim 10 wherein the overflow  
2        sensing means is coupled to the overflow reservoir, wherein  
3        said step of monitoring said state of the overflow sensing  
4        means comprises the step of using the overflow sensing means  
5        to check for presence of fuel in the overflow reservoir  
6        wherein said presence of fuel is indicative of said overflow  
7        condition.

1        12. A method according to claim 8 wherein a supply manifold  
2        is coupled between said controllable valve and the fuel  
3        tanks, wherein said step of monitoring said flow rate is  
4        carried out between said controllable valve and the supply  
5        manifold.

1        13. A method according to claim 12 wherein  
2                an overflow reservoir is coupled to the supply manifold  
3        with the overflow sensing means coupled to the overflow  
4        reservoir, and  
5                said step of monitoring said state of the overflow  
6        sensing means comprises the step of using the overflow  
7        sensing means to check for presence of fuel in the overflow  
8        reservoir wherein said presence of fuel is indicative of said  
9        overflow condition.